Resume of the proposed research topic on

Early Diagnosis of Alzheimer Disease using EEG Signals

By

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Abstract:

Neurodegenerative diseases are a group of disorders that affects the brain cells. These diseases are related with changes in the brain that lead to loss of brain structure or loss of neurons, including the death of some neurons. Alzheimer's disease (AD) is one of the most well known neurodegenerative diseases & it is the common form of dementia. There is no cure for this disease in last stage. However, there are some medicaments that may delay the symptoms if they are used during the first stages of the disease, otherwise they have no effect. Therefore early diagnose is presented as a key factor.

The different aspects related with neuroscience, in order to develop new methods for the early diagnose of AD. Different aspects have been investigated, such as signal preprocessing, feature extraction, feature selection and its classification. Preprocessing of raw EEG data is also presented by use of Independent Component Analysis & Wavelet based Denoising methods. Several features of EEG signals were computed in order to distinguish between two groups i.e. Alzheimer's disease & Normal subjects. Spectral Based features & Wavelet Based features were although used in studies; we claimed the hypothesis in this study that EEG signal of AD patients seems to be less complex as compared to Normal subjects. To verify our hypothesis, we investigated the use of new features termed as complexity based features. Spectral Entropy, Spectral Roll-off, Spectral Centroid & Zero Crossing Rate were computed in order to distinguish between two groups. We classified the data between two groups by use of supervised classifiers such as Support Vector Machines & K Nearest Neighbor. The proposed system achieved the 96% accuracy by use of Support vector machine & 94% accuracy by use of K Nearest Neighbor classifier on the database used in the study. The proposed system identifies whether the patient is suffering from Alzheimer's disease or either he is normal by use of different features used in the study. Thus, this system can help the

doctors, clinicians to diagnose the patient from Alzheimer's disease which was main goal of our research work.

1. Introduction: Origin of Research Problem:

Alzheimer's disease (AD) is a Neuro-degenerative disease, the most common form of dementia, third most expensive disease and sixth leading cause of death in the United States [1].AD) is the most common neurodegenerative disorder characterized by cognitive and intellectual deficits and behaviour disturbance. While no known cure exists for Alzheimer's disease, a number of medications are believed to delay the symptoms (and perhaps causes) of the disease [2].

The progression of the disease can be categorized in four different stages. The first stage is known as Mild Cognitive Impairment (MCI), and corresponds to a variety of symptoms most commonly memory loss which do not significantly alter daily life. Between 6 and 25% of people affected with MCI progress to AD every year. The next stages of Alzheimer's disease (Mild and Moderate AD) are characterized by increasing cognitive deficits, and decreasing independence, culminating in the patient's complete dependence on caregivers and a complete deterioration of personality (Severe AD) [3].

There is no cure for the Alzheimer's disease, which worsens as it progresses, and eventually leads to death. It was first described by German psychiatrist and neuropathology's Alois Alzheimer in 1906 and was named after him.

A. Importance of Diagnosis of Alzheimer Disease:

Early Diagnosis of Alzheimer Disease is needed for the following reasons:

1. A positive diagnostic gives the patient and his family time to inform them about the disease, to make life and financial decisions related to the disease, and to plan for the future needs and care of the patients [4].

2. A negative diagnostic may ease anxiety over memory loss associated with aging. It also allows for early treatments of reversible conditions with similar symptoms (such as thyroidal problems, depression, and nutrition or medication problems) [5].

3. Current symptoms-delaying medications have a given time frame during which they are effective. Early diagnosis of AD helps ensure prescription of these medications when they are most useful.

4. Early diagnosis of AD also allows prompt treatment of psychiatric symptoms such as depression or psychosis, and as such reduces the personal and societal costs of the disease [6].

5. As research progresses, preventive therapies may be developed. Early diagnosis raises the chance of treating the disease at a nascent stage, before the patient suffers permanent brain damage.

6. Finally, as institutionalization accounts for a large part of health care costs incurred because of AD, by preserving patients' independence longer and preparing families for the needs of AD patients, timely diagnosis further decreases the societal cost of the disease [7].

B. Causes of the Alzheimer Disease:

The cause for most Alzheimer cases is still mostly unknown except for cases where genetic differences have been identified. Several hypotheses are used for understanding the cause of the Alzheimer disease:

a) Genetics hypothesis: Around 0.1% of the cases are familial cause of this kind of inheritance. This form of the disease is known as early onset familial Alzheimer's disease.

b) Cholinergic hypothesis: It proposes that the AD is caused by reduced synthesis of the neurotransmitter acetylcholine.

c) Amyloid hypothesis: The amyloid hypothesis postulates that extracellular beta-amyloid (A) deposits are the fundamental cause of the disease.

d) Tau Hypothesis: The idea behind this hypothesis was that tau protein abnormalities initiate the disease cascade.

Another hypothesis asserts that the disease may be caused by the age related myelin breakdown in the brain.

C. Symptoms of the Alzheimer Disease:

The following are the symptoms of the Alzheimer disease:

a) The first symptoms are often mistakenly attributed to ageing or stress. These early symptoms can affect the most complex daily living activities First stage of the disease is termed as the Mild cognitive Impairment (MCI) in which Common symptom is of memory loss.

b) Next is the Mild & Moderate AD characterized by increasing cognitive deficits, and decreasing independence, culminating in the patient's complete dependence on caregivers and a complete deterioration of personality (Severe AD).

c) Language problems are mainly characterized by a shrinking vocabulary and decreased word fluency, which lead to a general impoverishment of oral and written language. In this stage, the person with Alzheimer's is usually capable of communicating basic ideas adequately.

d) In the next stage, behavioral and neuropsychiatric changes become more prevalent. Common manifestations are wandering, irritability and labile affect, leading to crying, outbursts of unpremeditated aggression, or resistance to caregiving. Sun downing cans also appearing. Approximately 30% of people with AD develop illusionary misidentifications and other delusional symptoms. Subjects also lose insight of their disease process and limitations (anosognosia). Urinary incontinence can develop. These symptoms create stress for relatives and caretakers, which can be reduced by moving the person from home care to other long-term care facilities

e) During the final stage of AD, the person is completely dependent upon caregivers. Language is reduced to simple phrases or even single words, eventually leading to complete loss of speech. AD is a terminal illness, with the cause of death typically being an external factor, such as infection of pressure ulcers or pneumonia, not the disease itself.

2. Literature Survey: Review of Research and Development in the Subject:

Early diagnosis of Alzheimer's disease, and in particular diagnosis of MCI and Mild AD, is important, since medications are most effective at an early stage of the disease. Diagnosis of Alzheimer's disease is hard, however, and symptoms are often dismissed as normal consequences of aging. EEG is one of the types of the detection method. It is a non-invasive method. EEG seems an attractive brain imaging modality for diagnosing AD, since EEG recording systems are relatively inexpensive and (potentially) mobile. Numerous studies have investigated the potential of EEG as a diagnostic tool for AD. Considering this, we reviewed many different research articles from IEEE Transactions, Springer, Elsevier, International conferences, International Journals and many more research papers.

Jaeseung Jeong [25], States that Alzheimer's disease (AD) is the most common neurodegenerative disorder characterized by cognitive and intellectual deficits and behaviour disturbance. EEG has been used as a standard tool for diagnosing the AD in decades. Further, hallmark of EEG Abnormalities in AD patients are a shift of the power spectrum to lower frequencies and a decrease in coherence of fast rhythms. The paper reviews the important search of the EEG abnormalities in AD patients obtained from conventional spectral analysis and nonlinear dynamical methods. The abnormalities in the AD patients through EEG are characterized by the slowed mean frequency, less complex activity, and reduced coherences among cortical regions. The future work is associated with the improvement of the accuracy of differential diagnosis and early detection of AD based on multimodal approaches, longitudinal studies on nonlinear dynamics of the EEG, drug effects on the EEG dynamics,

and linear and nonlinear functional connectivity among cortical regions. The work concludes that the EEG has a utility as a tool for the early diagnosis of the disease. He has concluded in his review that the diagnostic accuracy of the EEG based on a broad survey of the literature is currently about 80%.

Fayao Liu et al [26] for early detection of AD had proposed many machine learning techniques. They had proposed a novel multiple kernel learning frameworks to combine multi-modal features for AD classification. It is scalable & easy to implement. They also proposed group lasso regularization, to enforce group sparsity among different feature modalities. This actually acts as a role of feature modality selection, while at the same time exploiting complementary information among different kernels. This is able to extract the most discriminative features for classification.

Rene Rodriguez et al [27]**,** stated that the goal of the presented study was to determine the possible impact of spectral EEG analysis to detect early functional changes in preclinical stages of familial AD. They had selected the three subjects for diagnosis with hereditary AD such as a Probable AD group, an asymptomatic carrier (ACr) group & a normal group. Their results were presence of beta-bands alteration in ACr groups in the absence of clinical sign. Fast frequency bands change mainly in gamma-frequencies, in people with clinical sign of mild cognitive impairment. They also suggested that a reduction of beta power is not only due to ageing, but may reflect an alteration of AD especially in the early stage.

J. Dauwels et al [18], have shown that mild cognitive impairment and AD cause EEG signals to slow down and mild cognitive impairment and AD are associated with increase of power in slow frequencies (delta- and theta-band) and a decrease of power in fast frequencies (alpha- and beta band). Nevertheless, increased gamma-band power has been reported in mild cognitive impairment and AD patients compared to healthy age matched control subjects.

Thibaut De Bock et al [28] had worked on the Early Detection of Alzheimer's Disease Using Nonlinear Analysis of EEG via Tsallis Entropy. Their study focuses on participants with mild cognitive impairment (MCI) and includes both a delayed visual match-to-sample (working memory) task and a counting backwards task (eyes closed) for comparison. The EEG data were quantified using Tsallis entropy, and the brain regions analyzed included the prefrontal cortex, occipital lobe, and the posterior parietal cortex. They concluded that Tsallis entropy-based qEEG analysis has been shown to be a highly promising potential diagnostic tool for MCI and early dementia.

Francisco J. Fraga [30] had proposed an EEG-based biomarker for automated Alzheimer's disease (AD) diagnosis, based on extending proposed "percentage modulation energy"

(PME) metric. It was done basically to improve the signal-to-noise ratio of the EEG signal, PME features were averaged over different durations prior to classification. Two variants of the PME features were Developed: the “percentage raw energy” (PRE) and the “percentage envelope energy” (PEE). Results showed that over 98% accuracy can be achieved with a support vector classifier when discriminating between healthy and mild AD patients. Thus, the above paper proposes the spectro-temporal EEG-based biomarker for Alzheimer’s disease detection.

Zhengjia Dai et al [35] had proposed the M3 approach to classify AD patients from healthy controls. M3 is multi-modal imaging and multi-level characteristics with multi-classifier. By applying the M3 to the AD dataset it led to a classification accuracy of 89.47%. The most discriminative features include default-mode and subcortical regions.

Simon-Shlomo Poil et al [31] had used the integrative EEG biomarkers to predict the diagnosis of Alzheimer disease at MCI stage Alzheimer’s disease (AD) is a devastating disorder of increasing prevalence in modern society. Mild cognitive impairment (MCI) is considered a transitional stage between normal aging and AD. They predicted that Electroencephalography (EEG) biomarker would provide anon-invasive and relatively cheap screening tool to predict conversion to AD. Their results showed that exploratory data mining and integration of multiple biomarkers might yield many exciting results on the large databases of neuroscience data build. By integrating six EEG biomarkers into a diagnostic index using logistic regression the prediction, sensitivity of 88% were achieved. Improvement in algorithms used for pre-selecting biomarkers was a future scope for their research work.

Justin Dauwels et al [32] had proposed that EEG of Alzheimer patients is slower. They have concluded that there exists the strong correlation between slowing and loss of complexity in two independent EEG datasets; which are (a) EEG of predementia patients (Mild Cognitive Impairment; MCI) and control subjects; (b) EEG of mild AD patients and control subjects. They also investigated that the potential of EEG slowing and loss of EEG complexity as indicators of AD onset. Relative power & complexity were used as the features to classify the MCI and Mild AD patients versus age-matched control subjects. After the combination of the above two measures, classification rates of 83% (MCI) was obtained.

Esteve Gallego-Jutgla [33] had proposed the method to detect the Alzheimer disease by means of synchrony measures in optimized frequency bands. They presented the frequency band analysis of AD EEG signals with the aim of improving the diagnosis of AD using EEG signals. Several synchrony measures were assessed through statistical tests (Mann–Whitney

U test); including correlation, phase synchrony and Granger causality measures. They investigated that the frequency range (5-6Hz) yields the best accuracy for diagnosing AD, which lies within the classical theta band (4-8Hz). The corresponding classification error is 4.88% for directed transfer function (DTF) Granger causality measure. Their results predicted that EEG of AD patients is more synchronous than in healthy subjects within the optimized range 5-6Hz, which is in sharp contrast with the loss of synchrony in AD EEG reported in many earlier studies. Furthermore, they are working on the large datasets to verify the effectiveness of the proposed approach. The ultimate objective of their research is to determine the most appropriate EEG frequency bands for diagnosing AD (and potentially other neurodegenerative diseases) with synchrony measures.

3. Aim & Objectives of Research:

The main objective of this work is to present new signal processing and machine learning methods for EEG, that are used for the early diagnosis of AD & Dementia. The main idea of this research work is to use existing methods from the signals processing field, and develop new ones, to analyze different EEG data sets. An important part of this work includes the extraction of relevant features (both Linear & Non – Linear) from EEG signals and its selection, which is related with the machine learning field. All main steps used in EEG data analysis & processing are explored, from the pre processing step to classification.

The main objectives of this work can be summarized as:

1. To understand methods / techniques for early diagnosis of Alzheimer Disease using EEG Signals using MATLAB SP, NN Toolbox and to start from the simulation of basic pre-processing, segmentation, feature extraction and classification steps
2. To re-examine, formulate and propose new algorithms and methods for the classification of Alzheimer Disease using EEG Signals**.**
3. Present a new frequency based approach that may increase the ratio at which AD patients are recognized in comparison with healthy subjects.
4. Define a feature selection technique that uses the parameters computed in the EEG signals and that facilitates the classification of patients against healthy subjects.
5. To perform a join study of all the methods presented in this work, combining all the different steps.
6. To compare the achieved results for higher accuracy in classification and overcoming the limitations of existing methods.

4. International and National status:

A. International status:

As of 2013, there were an estimated 44.4 million people with dementia worldwide. This number will increase to an estimated 75.6 million in 2030, and 135.5 million in 2050. Much of the increase will be in developing countries. Already 62% of people with dementia live in developing countries, but by 2050 this will rise to 71%. The fastest growth in the elderly population is taking place in China, India, and their south Asian and western Pacific neighbors. The nine countries with the largest number of people with dementia in 2010 (1 million or more) were China (5.4 million), USA (3.9 million), India (3.7 million), Japan (2.5 million), Germany (1.5 million), Russia (1.2 million), France (1.1 million) Italy (1.1 million) and Brazil (1.0 million) [35].

1) Harvard Health Publications, Harvard University proposed the Brain Scan as a method to diagnose the Alzheimer Disease.

2) Researchers at Rowan, Penn, and Drexel universities determined that Alzheimer's disease could be accurately diagnosed between 80 and 90 % of the time by using electroencephalogram (EEG) signals. So they had developed the system to diagnose the AD by using EEG signals.

3) Researchers led by Charles Smith, MD, at the University of Kentucky Medical Centre, performed brain scans and tests of mental ability on 136 people over the age of 65 who were considered normal at the beginning of the study.

4) M. Avvenuti et al from University di Pisa, Italy & UNB Saint John Canada, proposed the Non-intrusive Patient Monitoring of Alzheimer's Disease Subjects Using Wireless Sensor Networks.

5) Justin Dauwels from Nanyang technological University, Singapore had proposed that an EEG of Alzheimer patient is slower. Compression ratios were found to be significantly correlated to delta and theta band relative power, showing their strong correlation with relative power at low frequencies; also strong anti-correlation between compression ratios and beta relative power was observed.

6) Francesco Carlo Morabito and others from University "Mediterranea" of Reggio Calabria, Italy had used multi-variate Multi-Scale Permutation Entropy for Complexity Analysis of Alzheimer's disease through EEG. The technique is able to incorporate the simultaneous analysis of multi-channel data as a unique block within a multi-scale framework.

B. National Status:

At National level, the country is geographically large with many towns and villages located in remote rural areas. Few medical facilities exist to serve the large population that resides in

the villages. Only 20% of India's quality health-care facilities cater to 70% of Indians confined to rural communities [8]. India spends only 0.9% of GDP (Gross Domestic Product) for health; Whereas WHO (World Health Organization) recommends 5% [12] [9]. So there is lots of need to give attention to health related issues & especially telemedicine.

1) Venkatraman S from IIT, Guwahati, India was working on detection of Alzheimer disease using EEG recorded by selective de-noising of ocular artifacts.

2) K.G.Parthiban from Tamil Nadu, India was working on the spike detection from EEG signal with the aid of morphological filters & particle swarm optimization. By consideration of the variations in the EEG signals, we can conclude whether the patient is suffering from AD or not.

5. Significance of the Study in the Context of Current Status:

Early diagnosis of Alzheimer's disease and in particular diagnosis of MCI and Mild AD is important, since medications are most effective at an early stage of the disease. Diagnosis of Alzheimer's disease is hard, however, and symptoms are often dismissed as normal consequences of aging. EEG is one of the types of the detection method. It is a non-invasive method. EEG seems an attractive brain imaging modality for diagnosing AD, since EEG recording systems are relatively inexpensive and (potentially) mobile. Numerous studies have investigated the potential of EEG as a diagnostic tool for AD.

In people with AD the increasing impairment of learning and memory eventually leads to a definitive diagnosis. So there are many of the different techniques for detection of Alzheimer disease such as the neuroimaging techniques like MRI (Magnetic Resonance Imaging), fMRI(functional Magnetic Resonance Imaging) , Computer Tomography (CT Scan), Positron Emission Tomography (PET) etc. Several non invasive methods are used for detection of AD.

EEG is one of the types of the detection method. It is a non invasive method. EEG seems an attractive brain imaging modality for diagnosing AD, since EEG recording systems are relatively inexpensive and (potentially) mobile. Moreover, in contrast to most other non-invasive brain imaging methods, EEG has high temporal resolution, and may as a consequence contain crucial information about abnormal brain dynamics in AD patients. Numerous studies have investigated the potential of EEG as a diagnostic tool for AD [7-11].

As of 2013, there were an estimated 44.4 million people with dementia worldwide out of that 3.7 million were Indians. This means special attention must be given to this Alzheimer

Disease. Currently various researchers are working on similar concept of detecting Alzheimer Disease using EEG signals but most of them have got accuracy of near about 88%.

Diagnosis of Alzheimer Disease

Basically three major effects of AD on EEG have been observed: slowing of the EEG, reduced complexity of the EEG signals, and perturbations in EEG synchrony [12-16]. Now let us discuss each of them in detail

1. **Slowing of EEG signals:**

One of the major effects is EEG "slowing"; many studies have shown that Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD) causes EEG signals to slow down. MCI/AD is associated with an increase of power in low frequencies (delta and theta band, 0.5–8Hz) and a decrease of power in higher frequencies (alpha and beta, 8–30Hz) [17]. However, increased gamma band power (30–100Hz) has been reported in MCI/AD patients compared to healthy age-matched control subjects

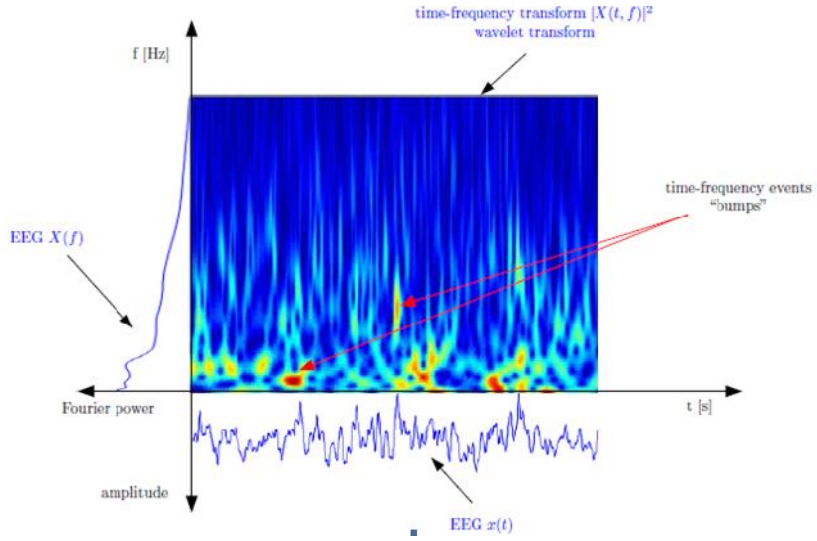

Figure.1 Slowing of the EEG signals: EEG signal, shown in time-domain x (t), frequency domain X (f), and time-frequency domain |X (t, f) |. [18]

Time-frequency maps of EEG signals are often sparse, as can be seen from Figure.1 most energy is contained in specific regions of the time-frequency map ("bumps"), corresponding to transient oscillations. A procedure was proposed to extract such transient oscillations from time frequency maps; it was shown that transient oscillations in the EEG of MCI and AD patients occur more often at low frequencies compared to healthy control subjects. In other words, those transient oscillations also exhibit slowing.

2. Reduced Complexity of EEG Signals:

Several studies have investigated the complexity of EEG signals in MCI and AD Patients. Various complexity measures have been used to quantify EEG complexity; some of them stem from information theory [18] [19] such as the Tsallis entropy[19], approximate entropy [21], multi-scale entropy[23][24], sample entropy & mutual information and Lempel-Ziv complexity[20]. All studies observed that the EEG of MCI and AD patients seems to be more regular (and, equivalently, less complex) than of age-matched control subjects. Due to the MCI/AD induced loss of neurons and perturbed anatomical and/or functional coupling, fewer neurons interact with each other, and the neural activity patterns and dynamics become simpler and more predictable. Moreover, it is possible that the MCI/AD induced phenomenon of reduced complexity is related to slowing, since "slower" (low pass) signals are intrinsically more regular.

3. Perturbation of Synchrony Measures:

Many different measures of synchrony have been employed in the physical sciences, signal processing and in the study of neurobiology. Many of these techniques have overlapping properties while some are substantially different. All seek to quantify the relationship between two signals or sensors and, by extension, the sources they represent. Numerous studies have reported decreased EEG synchrony in MCI/AD patients. The main problem is that most studies use just one measure or very few measures, and many of those studies analyze different data sets; consequently, it is difficult to rigorously compare the various measures. One should keep in mind, however, that it is hard to directly interpret results obtained with synchrony measures. Synchrony measures obtained from EEG signals may be significantly affected by brain events other than changes of synchrony, and by choices (like the reference electrodes) that necessary have to be made during the analysis. Several of the Synchrony measures can be applied such as the Pearson Correlation Coefficient, Magnitude and Phase Coherence, Granger Causality, Phase Synchrony etc.

6. Methodology

In our proposed methodology, firstly we will acquire the EEG signal by using the EEG electrodes. The EEG electrode cap is used for the signal acquisition which is put on the patient's head for recording of the signal. For the placement of the electrodes, we will be using the standard 10-20 electrode system. The required data will be collected from hospitals & from Standard data base.

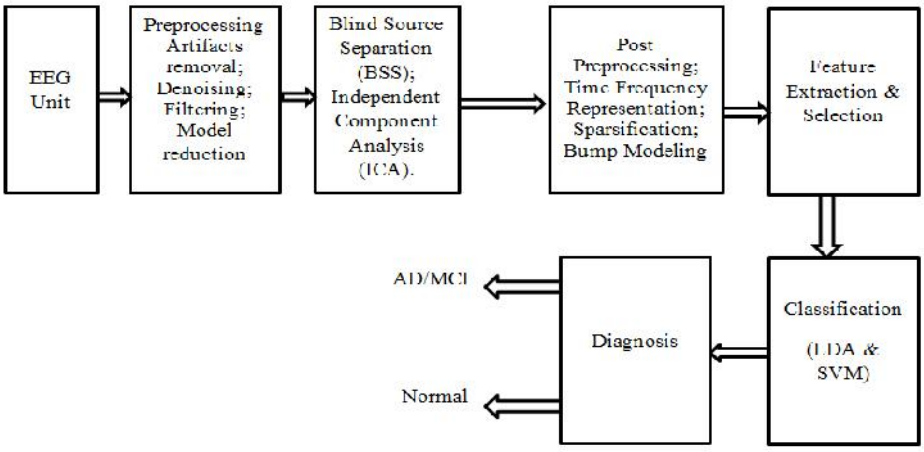
EEG Unit
Preprocessing Artifacts removal; Denoising; Filtering; Model reduction
Blind Source Separation (BSS); Independent Component Analysis (ICA).
Post Preprocessing; Time Frequency Representation; Sparsification; Bump Modeling
Feature Extraction & Selection
Classification (LDA & SVM)
Diagnosis
AD/MCI
Normal

Fig 2: Block diagram of proposed system

EEG Unit: This is used for measurement of EEG signal. This is done by using the electrodes. Many BCIs use a special *electrode cap*, in which the electrodes are already in the right places, typically according to the international 10-20 system. Typically, less than 10 electrodes are used in online) BCIs with sampling rates of 100-400 Hz.

Pre-Processing: This includes amplification, initial filtering of EEG signal artifact removal. Also A/D conversion is made, i.e. the analog EEG signal is digitized. Additionally to obtain more enhanced EEG signals various methods such as the Blind Source separation, independent component analysis are used. After the above method again the EEG signal is post processed using the time frequency domain. Various techniques such as the Wavelet transform, Sparsification & Bump Modeling are used for the same.

Feature Selection & Extraction: In this stage, certain features are extracted from the pre-processed and digitized EEG signal. In the simplest form a certain frequency range is selected and the amplitude relative to some reference level measured. Typically the features are certain frequency bands of a power spectrum. The power spectrum (which describes the Frequency content of the EEG signal) can be calculated using, for example, Fast Fourier Transform (FFT), the transfer function of an autoregressive (AR) model or wavelet Transform. On the other hand, if the feature sets are distinct enough, any classifier can classify them. Also, after bump modeling, the signals under investigation are represented by the set of parameters that describe the bumps.

Classification: The features extracted in the previous stage are the input for the classifier. The classifier can be anything from a simple linear model to a complex non-linear neural network that can be trained to diagnose the disease. In our proposed methodology, Linear Discriminant

Diagnosis: Based on the output of the Classifier, we can detect whether the person is suffering from Alzheimer Disease or he is in the early stage of the AD called as the Mild cognitive impairment (MCI).

EEGLAB is found to be an interactive MATLAB toolbox that is used for processing the continuous and event-related EEG, MEG and other electrophysiological data using Independent Component Analysis (ICA), time/frequency analysis, and other methods including artifact rejection. EEGLAB provides an interactive graphic user interface (GUI) allowing users to flexibly and interactively process their high-density EEG and other dynamic brain data using independent component analysis and/or time/frequency analysis (TFA), as well as standard averaging methods.

7. Expected Output of the Research

At the end of research work, it is expected that we get the high accuracy (up to 95%) of the EEG signal for detection of the Alzheimer disease. By watching the nature of the above signal according to the frequency bands classified we can also detect stage of the Alzheimer disease for example the early stage dementia, later stage Mild cognitive impairment (MCI) & last stage Severe Alzheimer disease.

A. Parameters for monitoring effectiveness of project

The important parameters are

1. Accuracy of the signal.
2. Quality of output signal.
3. Computational complexity (Can be measurable with Bio-O notation)

B. Suggested Post Research Activities

The future plans include the more reliable system for greater upto 100% accuracy of the signal for detection of the Alzheimer disease. The system can also be made portable in future.

8. Proposed work Plan/ Formulation and Structure of Study

Sr. No.	Activity	Duration In Months																
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
1	Literature Survey																		
2	Strength and weaknesses Identification of existing techniques.																		
3	Problem Definition and feasibility study																		
4	Design																		
5	Implementation																		
6	Testing																		
7	Thesis Writing																		
8	Publications																		

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